

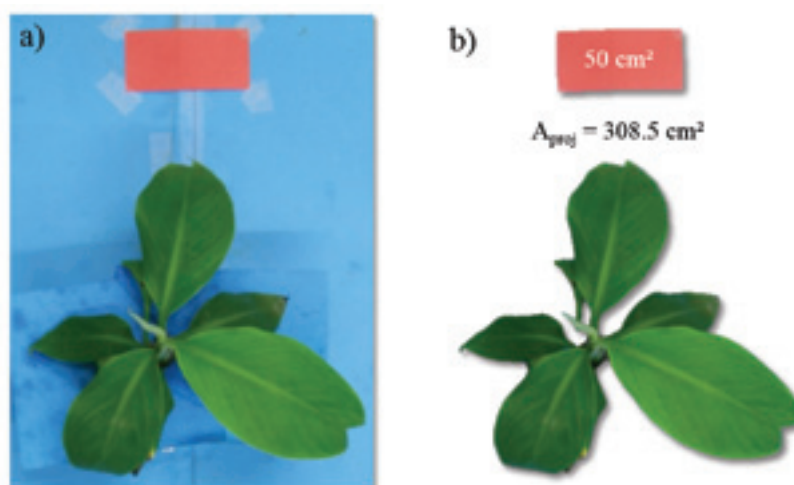
# Phenotyping for drought

For more information about the Bioversity International Musa Germplasm Transit Centre, see:

- Factsheet 1:  
*Operations, Outreach and Impact*
- Factsheet 2:  
*Unravelling the genetic basis of banana traits using Next Generation Sequencing technologies*
- Factsheet 4:  
*Screening for resistance to Fusarium wilt*
- Factsheet 5:  
*Use of banana diversity for nutritious diets*

Water shortage is an important limiting abiotic factor in agriculture, and the problem is expected to increase with climate change causing more frequent and more severe droughts in many areas. Banana needs vast amounts of water for optimal production. In commercial Cavendish export production systems, irrigation is routinely used, which has reduced the sense of urgency to exploit genetic resources with drought tolerance traits. However, most banana production systems are small-scale rain-fed systems. In addition, banana production tends to move into drier climates to escape black leaf streak, economically the most threatening disease for banana production. There is a need to reduce the dependency on irrigation water to make banana production more sustainable.

Through the efforts of Bioversity International and the support of the Belgian government and the Catholic University of Leuven (KULeuven), the world's largest banana collection is stored in Belgium at the Bioversity International Musa Germplasm Transit Centre (ITC). Reliable identification of drought-tolerant



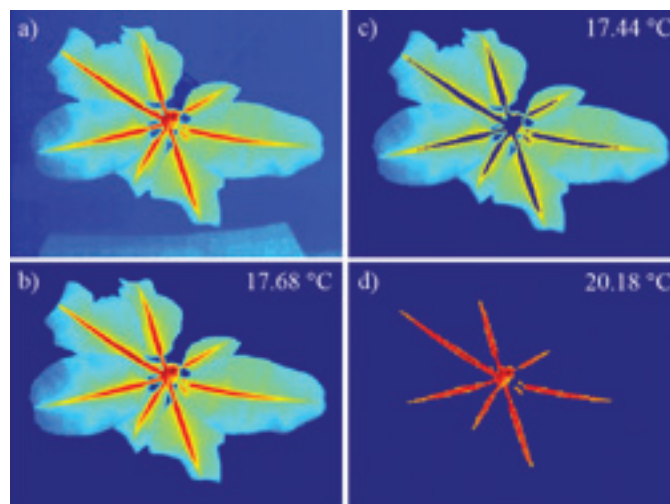
**Fig. 1:** Image of the projected leaf area of the plant and a red reference rectangle with known area, next to b) image after automatic extraction and calculation of leaf area by the software.

cultivars and an understanding of the mechanisms is urgently needed. Phenotyping, an emerging science that characterises plant behaviour and quantifies features such as growth and stress tolerance, offers a solution to gain such insights. Ultimately, the plant phenotype is driven by the operation of genes to regulate growth in coordination with environmental limitations. The KULeuven/Bioversity team investigates genes and their products at cell level, in the context of the whole plant.

## Progress

The ITC currently holds close to 1500 accessions, including 849 accessions available for distribution of which 687 are cultivated varieties. Having access to a high-throughput platform will allow screening the whole collection for drought-tolerant varieties and unlocking the potential of the banana gene pool. The bottlenecks in high-throughput phenotyping are the number of genotypes that need to be screened, the measurements that need to be performed and the data handling, and we address these in multiple ways.

To manage the number of genotypes, we **focus our research on the cultivated varieties**. There is great potential for exploiting drought-tolerant varieties within the group of edible bananas, since farmers will be able to directly use them in their production systems. We have **assembled a reference set** of 21 genotypes that covers the diversity of cultivated varieties and have **developed several systems to monitor growth and plant responses to stress** (such as plant area, leaf temperature). The implementation of those systems has not only increased the speed of taking measurements, but has also reduced the technical variation. To manage the number of measurements, we have **reduced the number of plant variables to the most powerful ones**, so that more accessions can be compared in the same timeframe and under similar conditions. To understand plant behaviour of the different cultivars, we correlate the changes on the plant level to the changes on the cell level.



**Fig. 2:** Temperature distribution in a banana plant using a FLIR B400 infrared camera. a) the raw image captured by the camera; b) the plant (minus surroundings) and its average temperature; c) the laminae of the leaves and their average temperature; d) the midribs of the leaves and their average temperature.

## Looking ahead

This work has several important implications and will allow us to:

- Publish technical guidelines for drought evaluations and train scientists from all over the world.
- Evaluate the whole ITC collection, and rank the banana biodiversity according to drought tolerance as an incentive to use the biodiversity more.
- Get insight into drought tolerance mechanisms/genes so that classical breeding can be sped up and genes can be used for biotechnological crop improvement.

## Partners

